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DEVELOPMENT OF A SOIL MONITORING & SOIL DATA MANAGEMENT DEMONSTRATION SYSTEM FOR REGIONAL SOIL SCIENTISTS & THE INTERMOUNTAIN RESEARCH STATION

by Martin F. Jurgensen

FINAL REPORT FOR RESEARCH AGREEMENT
#INT-93791- - AJVA
"Development of a Soil Monitoring and Soil Data Management Demonstration System for Regional Soil Scientists and the Intermountain Research Station"
MICHIGAN TECHNOLOGICAL UNIVERSITY
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Final Report for Research Joint Venture Agreement INT-93791-RJVA (Original agreement and Amendment 1)

June 8, 1993 through September 30, 1996

Submitted to:

U.S. Forest Service.
Intermountain Research Station
Forestry Sciences Laboratory
Moscow, Idaho 83843

Submitted by:

Martin F. Jurgensen
School of Forestry and Wood Products
Michigan Technological University
Houghton, Michigan 49931

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INTRODUCTION

This report summarizes work conducted during the funding period (June 8, 1993 to September 30, 1996) of a Research Joint Venture Agreement between the Intermountain Research Station and Michigan Technological University. The overall purpose for this Cooperative research project was to development a soil monitoring and soil data management demonstration system for regional soil scientists and the Intermountain Research Station. This study had three primary objectives:

A. Compile available soil management information for soil monitoring standards applicable to Region 1, using published literature, forest data, and experiences of key regional specialists.

B. Develop an applications/demonstration package for the above information that is usable by regional soil scientists and other specialists requiring soil impact or monitoring data and other interpretations. Package to be computer based, interactive, and tentatively based on the Hypertext programming system.

C. Develop the system and its data access procedures in a manner consistent with interfacing both Regional (ECODATA) and INT- 4551 soil data management procedures.

This report is organized by these three study objectives.

ACCOMPLISHMENTS

A. Compile available soil management information for soil monitoring standards applicable to Region 1, using published literature, forest data, and experiences of key regional specialists.

Literature on soil properties and management which are applicable to national forests in Region 1 were compiled from various forestry and soil science reference data bases. Jeff Lewin (Research Associate - MTU) was the lead scientist on this project. He was able to identify 275 papers and reports which were suitable for this project. These are listed in Appendix A. Copies of these papers were also obtained, and their abstracts will be entered into the SOLO Hypertext Soil Management Information System when applicable (see Objective B). This research objective has been completed.

B. Develop an applications/demonstration package for the above information that is usable by regional soil scientists and other specialists requiring soil impact or monitoring data and other interpretations. Package to be computer based, interactive, and tentatively based on the Hypertext programming system.

This task required the most effort, and was the most comprehensive of the research conducted under this cooperative agreement. Working in close cooperation with Tom Rice (RWU-4551), meetings were held with Regional Soil Scientists (Mark Jensen and John Nesser - RO1) and soil scientists from many forests in Region 1 to develop the organizational framework for a soil management information system. The computer-based, interactive Hypertext programing system was selected as being appropriate for this task. A prototype, SOLO - an interactive expert system for SOil quality monitoring and LOng term ecosystem sustainability, was developed (Appendix B), and demonstrated to representatives from the regional office and from various national forests. These NFS soil scientists were highly supported of the SOLO system, and recommended it be presented to all Region 1 soil scientists at a meeting in May 1997. This research is on-going, and will be continued in future cooperative agreements with RWU - 4551.

C. Develop the system and its data access procedures in a manner consistent with interfacing both Regional (ECODATA) and INT-4551 soil data management procedures.

While most effort in this cooperative project has centered on developing the appropriate computer information system (Objective B), information entry and data access procedures for both regional and INT soil information and research results (see Objective A) were also evaluated. A hierarchical outline was developed using both geographic and soil management subjects, which will be used in entering appropriate soil information (*e.g.* reports, published papers, professional observations) into the SOLO Hypertext system. Parameters of this classification system are shown in Appendix C. These parameters will likely change or be refined, based on suggestions from NSF soil scientists as the Hypertext system is tested on several national forests in Region 1 during 1997. This work will also continue in future cooperative agreements with RWU - 4551.

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Clifford 1988
Geist and Cochran 1991
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Geist et al 1990
Graham et al 1991
Grier et al 1989
Henderson et al 1990
Jurgensen et al 1990
Miller et al 1974
Miller 1989
Perry 1989
Powers 1990
Swanson et al 1989
Utzig and Walmsley 1988

Measurement and methodology:

Campbell and Hunter 1986
Eavis et al 1969
Erbach et al 1991
Hazard and Geist 1984
Hazard et al 1985
Sharma and De Datta 1985

Papers discussing site preparation effects on soil (and difficult to pigeonhole otherwise):

Cole and Schmidt 1986
Gent et al 1983
Kratch 1985
Malac 1976
Miller and Breuer 1984
Minore and Weatherly 1988
Morris and Pritchett 1983
Morris and Lowery 1988
Pehl 1984
Pehl and Bailey 1983
Ross et al 1986

Long-term forest productivity (harvesting):

Aber et al 1978
Aber et al 1979
Alban 1991
Albert and Barnes 1987
Amaranthus et al 1989

Bigger and Cole 1983
Clayton and Kennedy 1985
Fiedler et al 1985
Forristall and Gessel 1955
Graumlich et al 1989
Harvey et al 1980
Harvey et al 19xx
Jensen 1992
Klock 1982
Perala 1979
Reisinger et al 1988
Squire 1983
Stark 1982
Sullivan 1987

Disturbance:

Berry 1979
Carmean 1954
Clayton 1990
Clayton et al 1987
Courtin et al 1983
Hall et al 1982
Indorante and Jansen 1984
Krag 1991
Krag et al 1986
Martin 1988
Miller and Newton 1983
Miller and Sirois 1986
Page-Dumroese et al 1986
Pomeroy 1949
Ryan et al 1992
Smith and Wass 1976
Smith and Wass 1979
White 1991
Wicklow and Whittingham 1974

Soil displacement:

Dregne 1982
Hatchell et al 1970
Helvey et al 1985
Johnson and Beschta 1980
Klock 1982
Langdale and Shrader 1982
McCormack et al 1982
McNabb 1985
McNabb 1986
Miles and Swanson 1986
NSESPRPC 1981
Schumm and Harvey 1982
Schwab and Watt 1981
Skidmore 1982
Sloan and Ryker 1986

Smith and Wass 1989
Tiarks 1990
Vories and von Bernuth 1990
Williams and Buckhouse 1993

Vegetation management:

Knapp et al 1984

Above ground organic matter:

Benson 1982
Blake and Ruark 1990
Covington 1981
Edwards and Ross-Todd 1983
Flinn et al 1980
Harmon et al 1986
Harvey et al 1987
Harvey et al 1983
Johnson 1992
Mattson and Swank 1989
McLeod et al 1979
Moore and Norris 1974
Nyland et al 1979
Packer and Williams 1980
Ruth 1974
Ruth and Harris 1975
Schmidt and Lotan 1980
Seidel 1974
Shearer 19780
Spies et al 1988

Mechanics of compaction:

Barley 1962
Carter 1990
Cruse and Gupta 1991
Davis 1992
Donnelly et al 1991
Dyrness 1965
Dyrness 1967
Dyrness 1972
Eavis 1972
Edwards and Burney 1989
Froehlich 1979
Froehlich et al 1985
Koger et al 1984
Koger et al 1985
Larson and Gupta 1980
Larson et al 1980
Miles 1978
Moehring and Rawls 1970
Ohu et al 1986
Page-Dumroese 1993

Radcliffe et al 1991
Willatt 1987

Forestry (natural and plantation) compaction - seedling and long-term studies.

Alexander 1981
Alexander 1983
Allbrook 1986
Broadfoot and Bonner 1966
Cochran and Brook 1985
Corns 1988
Cullen et al 1991
Cullen and Montagne 1981
Dick et al 1988
Donnelly and Shane 1986
Froehlich 1979a
Froehlich 1979b
Helms 1983
Helms and Hipkin 1986
Helms et al 1986
Pearse 1958
Pehl 1983
Perry 1964
Raghavan et al 1981
Sands and Bowen 1978
Sidle and Drlica 1981
Simmons and Pope 1987a
Snider and Miller 1985
Stransky 1981
Stransky et al 1985
Tworkoski et al 1983
Wert and Thomas 1981
Youngberg 1959
Zisa et al 1980

Greenhouse tree seedling experiments:

Armson and Williams 1960
Duffy and McClurkin 1974
Foil and Ralston 1967
Hatchell 1970
Heilman 1981
Minore et al 1969
Mitchell et al 1982
Simmons and Pope 1988
Simmons and Pope 1987b
Tuttle et al 1988

Agricultural compaction:

Abdalla et al 1969
Assaday et al 1985
Assaeed et al 1990
Cruse and Gupta 1991

Fausy and Dylla 1984
Jones 1983
Russell and Goss 1974
Singh et al 1971
Taylor 1974
Taylor et al 1966
Taylor and Gardner 1963
Tu and Tan 1988
Veihmeyer and Hendrickson 1948
Vepraskas 1988
Voorhees 1992
Whiteley and Dexter 1984
Zimmerman and Kardos 1961

Compaction overview or review papers:

Adams and Froehlich 1981
Alexander and McLaughlin 1990
Daddow and Warrington 1983
Froehlich and McNabb 1984
Greacen and Sands 1980
Gupta et al 1989
Omi 1984
Patterson 1976
Rosenberg 1964
Ruark et al 1982
Voorhees 1991

Fire's effects on physical and chemical properties of soil.

Adams and Boyle 1980
Aust and Lea 1991
Benson 1980
Bisset and Parkinson 1980
Biswell and Schultz 1955
Borchers and Perry 1988
Braathe 1973
Covington and Sackett 1992
Covington and Sackett 1986
Debyle 1976
Flinn et al 1979
Fischer 1989
Giovannini et al 1987
Giovannini and Lucchesi 1983
Kovacic et al 1986
Kraemer and Hermann 1979
Kutiel and Naveh 1987
Little and Ohmann 1988
McKee 1982
McNabb et al 1989
Neal et al 1965
Packer and Williams 1974
Pehl et al 1986
Shearer 1975

Sims 1976
Smith and Wass 1980
Steele 1980
Wells et al 1979
White et al 1975
Viro 1974
Vlamis 1955
Vogal and Ryder 1969

Secondary effects of fire:

Covington and Sackett 1984
DeByle 1973
Durgin 1985
Feller 1983
Giovannini et al 1988
Miles et al 1984
Pilz and Perry 1984

Post fire vegetational effects:

Ahlgren and Ahlgren 1960
Beaufait et al 1977
Bosworth 1988
Bosworth and Studer 1991
Brown 1975
Campbell et al 1977
DeByle 1981
Ffolliot et al 1977
Grimm 1984
Harris and Covington 1983
Hunt and Simpson 1985
Juday 1985
Lotan et al 1978
Lyon 1971
Lyon 1976
McKevlin and McKee 1986
Ohmann and Grigal 1979
Oswald and Covington 1984
Rowe and Scotter 1973
Ryan et al 1988
Shearer 1976
Stickney 1985
Stickney 1986
Sutherland et al 1991
Thor and Nichols 1973
Vose and White 1991
Weaver 1974
Wood and Lindzey 1966
Wright 1978

APPENDIX B

Introducing SOLO:

an interactive expert system for SOil quality monitoring and LOng term ecosystem sustainability

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What is SOLO? SOLO is a computerized collection of representative documentation on soil monitoring and long term ecosystem sustainability, linked together electronically by topic, author, key word, or key concept. The information may be surveyed by activating push-buttons on the computer screen.

Why is SOLO being created? From a desire to consolidate and cross-reference all Regional soils information in a single library for electronic access, and to make that information available to Forest Service personnel in an organized, easily searchable, predigested format, SOLO was conceived to aid in decision-making processes involving forest planning, habitat quality maintenance, and mitigation of soil disturbance, whether human-induced or natural.

What kinds of information will SOLO contain? The main body of information in SOLO will contain abstracts and summaries of published and unpublished studies, analyses, reports, articles, papers, and data files, as well as generalized scientific assessments, learned opinions, gut feelings and anecdotes which are relevant to assessing and maintaining soil quality in a forest environment. Each item will be selected based on its applicability and/or its importance to the topic. A few articles of general importance will be included in their entirety.

How is the information in SOLO organized? A system of menus, submenus and maps is employed to organize the information geographically, as well as by land type, habitat type, ecozone, disturbance type or associated guideline, arena of influence, and effects related to a particular event or activity. Also included are discussions of methods for site selection, sampling, analysis and data interpretation, plus options for mitigation or avoidance of disturbance. Each item is referenced in a general bibliography and categorized by source, topic and discipline.

How can SOLO be used? SOLO is intended for use by forestry, soils, hydrology, engineering and land use professionals in planning and management of activities which will affect ecosystems, or in prevention or amelioration of the effects of natural disturbance events. The information in SOLO may be accessed via several pathways, e.g., activity or event, disturbance type, geographic location, or land type, habitat type, or soil property affected.

When will SOLO be available? SOLO is being developed in two phases:
Phase 1 is the programming of the user interface and document framework, which is complete for the material that is currently in the information base. A working version of Phase 1 will be available in November, 1995, to an advisory group, for testing and review.
Phase 2 is the compilation, parsing and linking of the larger body of information to be contained, and the expansion of the framework to accommodate it. A first release of Phase 2 is planned for the summer of 1996. It will be distributed to key personnel at Forest Supervisor's Offices throughout the Region.

Because forest soil research continues indefinitely, SOLO is a dynamic, evolving product which may never be "complete" in the definitive sense. New information will be incorporated as it becomes available, and feedback from users may dictate occasional changes in the system. Maintenance of SOLO's information base will be accomplished at the Regional level, by a person or persons as yet unnamed. New versions will be released on an occasional or need basis, depending on the volume and quality of the changes.

For more information, contact:
Tom Rice, INT Moscow, (208) 883-2308 (DG) T.Rice:S22L04A

APPENDIX C

Parameters for classification of SOLO entries:
(Please include as many as possible for each contribution)

Source and type

[ ] Publication:_____
_____
[ ]Peer-reviewed
[ ]Non peer-reviewed
[ ] Unpublished study/report/analysis:_____
_____
[ ] Data summary:_____
[ ] Professional opinion based on:_____
Location of source:_____

Physical description

[ ] Geographic location:
Forest:_____
Timber sale/Range allotment:_____
Watershed name & 8-digit HUC (4th code):_____
[ ] Land type/land type association:_____
[ ] Cover type/habitat type/structural stage:_____/_____/_____
[ ] Ecological subsection:_____ or Landform:_____
[ ] Surface/Bedrock:_____

Associated concern

[ ] Compaction
[ ] Displacement
[ ] Puddling
[ ] Burned soil
[ ] Erosion
[ ] Woody debris
[ ] Nutrient Cycling
[ ] Regeneration

Major area of influence

[ ] Soil productivity [ ] Hydrologic function
[ ] Soil biology
[ ] Soil chemistry
[ ] Soil physical properties
[ ] Soil climatic properties

Activity effects

[ ] Fire effects
[ ] Harvest effects
[ ] Site prep effects
[ ] Roading effects
[ ] Grazing effects
[ ] Mining effects
[ ] Unmanaged

Procedures

[ ] Site selection
[ ] Measurement
[ ] Sampling

GEOLOGY - BEDROCK/SURFICIAL

BEDROCK (GENERAL) (Process)	CODE	BEDROCK (SPECIFIC) (Material)	CODE
Igneous, Intrusive (Phanerites)	II	Granitics (granite, monzonite)	GR
		Mafics (diorite, gabbro)	MF
Intrusive, Alkalic	IA		
Igneous, Extrusive (Aphanerites)	IE	Rhyolite	RH
		Basalt	BA
Pyroclastic & Glass	PY	Scoria	SO
		Tuff	TU
		Mudflow & Breccia	MU
		Glass (incl. pumice)	GL
Sedimentary, Quartz-rich	SE	Sandstone	SS
		Shale	SH
		Siltstone	SI
		Conglomerate	CO
Sedimentary, Quartz-poor	SP	Limestone	LI
Sedimentary, Carbonate	SC	Dolomite	DO
		Conglomerate	CO
Sedimentary, Calcareous	SA		
Metasedimentary	MS	Argillite	AR
		Quartzite	QU
		Schist	ST
		Meta-siltstone	MI
Metasedimentary, Calcareous	MC		
Metavolcanic	MV	Greenstone/Mafic Schist	GS
		Ultramafics	UM
Metamorphic	ME	Gneiss	GN
		Amphibolite	AM

GEOMORPHOLOGY - LANDSCAPE/LANDFORM/POSITION

LANDSCAPE	CODE	LANDFORM	CODE
Mountains	MO	Avalanche Track	AV
Glaciated Mountains	MG	Basin Floor	BC
		Block Field	BF
		Caldera	CD
		Canyon	CA
		Cirque	CQ
		Dipslope	DS
		Drumlin	DR
		Escarpment	ES
		Fault-line Scarp	FS
		Floodplain	FP
		Graben	GB
		Headwall	HW
		Horst	HO
		Kame	KA
		Kettle	KE
		Landslide	LD
		Moraine	MR
		Mountainside	MS
		Nunatak	NU
		Ridge	RI
		Structural Bench	SB
		Trough	TR
		Volcanic Cone	VC
Foothills	FH	Hillside	HS
Hills	HI	Ridge	RI
		Draw	DW
		Drainageway	DN
		Landslide	LD
Breaks	BK	Steam Breaks	ST
		Structural Breaks	BS
Badlands	BA	Hillside	HS
		Fan	FN
		Draw	DW
		Butte	BU
		Drainageway	DN
		Landslide	LD

LANDFORM	CODE
Breaks	BK
Foothills	FH
Glaciated Mountains	MG
Intermontane Basin	IB
Mountains	MO
Plain	PL
Plateau	PT
Till Plain	TP
Valley	VA

Steep	(31-60%)	ST
Very Steep	(>60%)	SV

SLOPE SHAPE

Concave	CC
Convex	CV
Plane	PL

WIDTH (used to describe width of landforms such as valley floors, benches, terraces, ridges, and drainageways)

Narrow (<100 ft)	NW
Intermediate (100-300 ft)	IT
Wide (>300 ft)	WI

Intermontane Basin	IB	Alluvial Fan	AF
		Flood Plain	FP
		Fluvial Terrace	FT
		Outwash Plain	OP
		Outwash Terrace	OT
Plain	PL	Alluvial Fan	AF
Till Plain	TP	Butte	BU
Lacustrine Plain	LP	Drumlin	DR
Delta Plain	DE	Dune	DU
		Flood Plain	FP
		Fluvial Terrace	FT
		Kame	KA
		Kettle	KE
		Hummock	HU
		Swale	SW
		Draw	DW
		Drainageway	DN
		Knoll	KL
Plateau	PT	None	
Valley	VA	Valley Side	VS
		Valley Floor	VF
		Flood Plain	FP
		Fluvial Terrace	FT
		Alluvial Fan	AF
		Pediment	PE
		Abandoned Meander	AM
		Oxbow	OX
		Backwater Slough	BS
		Stream Channel	SC
		Stream Bar	SB
		Levee (natural)	LE
		Drainageway	DN

SLOPE COMPONENT (used to describe slope position on landforms such as hillsides and mountainsides)

Summit	SU
Shoulder	SH
Backslope	BP
Footslope	FS
Toeslope	TS
Depression	DP
Interfluve	IF

SLOPE GRADIENT (used to describe the general slope of landforms such as plains)

Level	(0-3%)	LV
Undulating	(4-8%)	UN
Rolling	(9-16%)	RO
Hilly	(17-30%)	HL

AD-33 Bookplate
(1—63)

NATIONAL

LIBRARY

RMRS Library - Ogden

Library - Ogden Center
Rocky Mountain Research Station
324 25th Street
Ogden, UT 84401